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Portsmouth and Paducah Gaseous Diffusion Plant
Decontamination and Decommissioning Estimate

Parametric Relationships Within Cost Estimate and Recommendations to Minimize Costs; Analysis of Converter Stabilization Methods

August 31, 2006

Prepared For:
U.S. Department of Energy
Portsmouth Gaseous Diffusion Plant
Piketon, Ohio

Prepared By:
U.S. Army Corps of Engineers – Huntington District
Project Time & Cost, Inc.
TLG Services, Inc.
Project Enhancement Corporation

US Army Corps of Engineers®

Project Time & Cost

PROJECT ENHANCEMENT CORPORATION

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Project Time & Cost

August 31, 2006

PROJECT TIME & COST, INC.
2727 Paces Ferry Road
Suite 1-1200
Atlanta, GA 30339
(770) 444-9799
Fax (770) 444-9808
www.ptcinc.com

U.S. Department of Energy
Portsmouth/Paducah Project Office
X1000 Building
3930 US Route 23 South
Piketon, OH 45661

ATTN: Mr. Judson Lilly

RE: Portsmouth/Paducah Gaseous Diffusion Plant
Decontamination and Decommissioning Cost Estimate
Portsmouth Deliverable No. 6 – Parametric Relationships Within Cost Estimate and Recommendations to Minimize Costs; Analysis of Converter Stabilization Methods

Contract No. W91237-05-D-0020, Delivery Order No. 11

Dear Mr. Lilly:

Pursuant to the requirements in the above referenced contract and delivery order, Project Time & Cost, Inc. has completed Portsmouth Deliverable No. 4, Parametric Relationships Within Cost Estimate and Recommendations to Minimize Costs; Analysis of Converter Stabilization Methods. Enclosed you will find 3 hard copies and 3 electronic copies of our submittal for your review.

This submittal is in addition to the electronic copies of these reports that were distributed via e-mail to you, Mr. Jeremy Stevenson and Mr. Dean Hammonds of the USACE Huntington District on August 31, 2006.

Thank you for giving Project Time & Cost, Inc. the opportunity to work with DOE-PPPO on this important project. I trust the information provided is all inclusive for your needs; however, if you have any questions or require additional information please do not hesitate to contact me at 770-444-9799.

Sincerely,
PROJECT TIME & COST, INC.

Brian T. Aubel
Cost Engineer, Special Projects

A. Introduction

The Department of Energy (DOE) at Portsmouth has arranged with the U.S. Army Corps of Engineers – Huntington District (USACE) to develop preliminary cost estimates for the Portsmouth Decontamination and Decommissioning (D&D) Project. The USACE Team consists of personnel from the Corps, Project Time & Cost, Inc., TLG Services, Inc., and Project Enhancement Corporation. The USACE Team was tasked by DOE to develop preliminary estimates, schedules, and other deliverables for seven D&D scenarios for Portsmouth.

The Portsmouth D&D Project assumes the decontamination and decommissioning, including demolition, of 134 facilities at the Portsmouth Gaseous Diffusion Process (GDP) plant near Piketon, Ohio. The 134 facilities comprise nearly 10,600,000 square feet of floor space (see Table A-1 Summary of Facility Inventory and Table A-2).

Category	Sub-Category	Construction Type	Gross Area (GSF)	Number of Structures
Industrial	Non-Radiological	Concrete	362,623	12
Industrial	Non-Radiological	Wood	37,000	7
Industrial	Non-Radiological	Other	299,654	20
Industrial	Radiological	Concrete	128,852	1
Industrial	Radiological	Other	224,074	5
Laboratory	Radiological	Concrete	179,342	2
Non-Industrial	Non-Radiological	Concrete	36,864	5
Non-Industrial	Non-Radiological	Wood	166,449	7
Non-Industrial	Non-Radiological	Other	674,683	63
Non-Industrial	Radiological	Concrete	245	1
Non-Industrial	Radiological	Other	103,107	5
Process	Radiological	Other	8,337,455	6
Total Facilities			**10,550,348**	**134**

Table A-1 - Summary of Facility Inventory

Category	Sub-Category	Gross Area (GSF)	Number of Structures
Infrastructure	Ditches	n/a	4
Infrastructure	Fences	n/a	4
Infrastructure	Parking Lots	1,113,500	5
Infrastructure	Pits	750	1
Infrastructure	Roads / Railroads	n/a	6
Infrastructure	Tunnels	n/a	2
Infrastructure	Yards / Pads	55,516	30
Infrastructure	Rubble Piles	n/a	2
Infrastructure	Other	n/a	3
Utilities	Switchyard	n/a	3
Utilities	General Utilities	n/a	49
Total Miscellaneous Facilities		**1,169,766**	**109**

Table 2.0-2 - Summary of Infrastructure and Utilities Inventory

The estimate consisted of six scenarios, developed to support the DOE effort in reaching the Critical Decision-1 (CD-1) milestone requirements for the Portsmouth D&D Project and to provide data for their triennial report to Congress on the D&D Fund. This report is to state the cost saving observations and parametric decisions made by the Project Time & Cost, Inc. estimating team.

B. Cost Minimization Analysis

1.0 Executive Summary

PT&C focused on four main areas that could yield savings in the performance of the D&D work for the Portsmouth GDP facility. These savings were in the areas of Project Duration (Scheduling), Utility Management & Demolition, Work Performance (Sequencing and Prioritization) and Recycling (Raw Materials and Use of Facilities).

2.0 Recommendations

Incorporated in this section are recommendations from the project review team of items that could be done differently than was envisioned by the project scenarios, or were restricted in the scenarios by the project assumptions. The actual savings of these suggestions have not been estimated, as they were either not in the scenario scope, or were ruled out by the project assumptions, but the logic for potential savings is discussed here.

2.1. Project Duration

LOE and Owner's Rep costs are directly related to the duration of the project. Since these are the two highest cost elements in the project, total project cost will be reduced dramatically if the project schedule can be compressed. This can be achieved by sequencing activities in parallel. This would increase the complexity of the schedule, but would allow any segment of specialists and equipment to progress to the next building in a sequence, while follow-up crews work on the next stage of the building demolition behind them.

Additionally, the duration of the LOE could be reduced by the usage of two or three shift scheduling. While this would increase the extent of the labor portion of the LOE, it would have no effect on the extent of the equipment portion of the LOE, and would also reduce the duration of the LOE.

2.2. Utilities

The best cost savings that can be achieved in the removal of utilities consists in leaving all or some underground systems in place and filled with sand slurry. This would save the cost of excavation and other earthwork and lessen the volume of waste generated. As the final land status of this site will be industrial/brownfield, the clean utilities and tunnels could be left in place intact to serve the needs of future reindustrialization of the site. This includes power, fresh water, some sanitary sewers, communication, some rail spurs, and roadways.

Another major cost avoidance involves not excavating off site clean utilities, but rather abandoning them in place, or backfilling with sand slurry to minimize any

eventual subsidence (if any). This especially applies to the ~6 miles of water main from the plant water facility back to the Scioto River intake in Piketon. This will save the costs of excavation, damage/disruption to state and federal highways, damage/disruption to Norfolk Southern rail lines, and eliminate possible eminent domain action to property in Piketon itself.

Minor savings could be achieved by leaving all underground utility and infrastructure demolition until the end of the project and conduct the work based on quadrants, or some other organized surface area. This would eliminate excavation crews performing linear excavation across the site while other work is being conducted. It would curb accidental removal or cutting of utilities which are still in use, and would aid in confirmation that no systems or parts of systems have been accidentally left in place.

2.3. Work Performance

Conduct the work items that require L clearances first so the site security levels can be lessened as soon as possible. Once the security level has been dropped the amount of security escorts can be decreased, dropping the extent of LOE.

The largest cost items within the LOE and Owner's Rep are the salaries of the Engineers, Scientists, and Subject Matter Expert. In order to lessen the amount paid out, complete work that needs these highly technical and highly paid Engineers, Scientists, and Subject Matter Expert as quickly as possible in an effort to reduce FTE's. Such work items include the D&D of the process buildings, and demolition of contaminated ancillary facilities. This curbing of the duration of LOE could be aided by the elimination of slab and foundation removal of the GDP buildings. As for the most part these slabs and foundations are uncontaminated, large LOE savings would be realized in leaving the slabs in place, either exposed or shallowly buried. This could eliminate months out of the LOE duration. Given Portsmouth end status as an industrial/brownfield site, leaving the slabs in place would not be inconsistent.

It might be advantageous to divide the D&D contract into two pieces, one for GDP and other radiation contaminated buildings, and the other for the uncontaminated facilities. This would allow the LOE featuring the greater extent of specialized workers and equipment to be curtailed, and replaced by a simpler LOE for the balance of the buildings.

Hire experienced, and a fully manned staff to manage the Onsite Readiness Reviews (ORR). The quicker ORRs can be completed, the less carrying cost for early project LOE that the Owner's Representative, and craft laborers will accumulate. This could be upwards of tens of millions of dollars for a long ORR process.

2.4.Recycling

In the debris from D&D of the GDP buildings and ancillary structures there should be significant quantities of uncontaminated recyclable materials. Given the current state of commodities markets (as of 7/5/06 scrap steel was selling for as much as $273/ton) the steel, copper, clean concrete and salvageable electrical equipment on-site could introduce a motivation for D&D contractors to lower their bids in exchange for the potential to cash in on the clean recyclable materials. It is understood that external considerations may make this recommendation difficult to implement.

Consider salvage of the machine shops and warehouse. This sort of facility will still be needed for the ACP. It makes little sense to tear down a facility that is still usable, just to replace it with a similar facility. By the narrative of Portsmouth personnel who exhibited the machine shop and warehouse to the review team, the building is in very good repair, and the machinery is still functional and useful. Despite the depreciated state of the machinery in accounting terms, to replace the buildings and usable machinery there with equivalents will easily cost up to the $100's of millions if all functions of the warehouse/machine shop need to be replaced.

Reuse of the cores of modern buildings (newer buildings, left with outer walls, slabs, and internal frame), in good maintenance should be considered. Given the site's eventual industrial/brownfield status, salvageable, uncontaminated buildings could be gutted out, but the shells left intact for quick future use by industrial/business occupants. This should not be taken to mean all buildings on site, regardless of contamination level. As experience on the ETTP project at Oak Ridge has demonstrated, reuse of heavily contaminated buildings can be a frustrating and potentially dangerous pursuit, despite the seeming potential of the building.

It has been stated to the PTC review team by Portsmouth staff that the electrical yards on-site are a functional part of the electrical grid in central southern Ohio. It should be considered that the site electrical yards be sold at nominal cost, or given to the local utilities. This will benefit the utility by eliminating the need to replace the capacity the current transformer yards provides, and by taking ownership, the utility would reduce the scope of the GDP D&D project.

2.5.Miscellaneous

Although not included in this estimate, incorporating environmental remediation (ER) to occur along with D&D will substantially lessen the cost of ER; effectively lowering the total PORTS project cost. One manner of doing so would be to not touch the soil until all above ground demolition has been completed, leaving the slabs in place. Once above ground demolition has completed the slabs can be removed and an ER team can follow conducting their work on the soils and other

ER projects. This would also bring savings to the on-site landfill, as a ready source of debris mix soils would be readily available, and eliminate the need for clean soil to be used as "filler".

There are several sanitary landfills within short driving distance of the site. Some have been quoted as saying that they can accept clean construction debris in quantities that would fulfill the GDP D&D quantities with no sizing restrictions. This could eliminate as much as 50% of total debris going to the landfill at a fairly low cost. There is also two TSCA licensed incinerators nearby, one in the southern suburbs of Cleveland and another in New Philadelphia, Ohio, as well as a comprehensive hazardous waste facility in Hammond, IN. If sanitary waste and TSCA waste can be shipped elsewhere the landfill will lose up to 60% of its current projected volume. This will greatly reduce the cost of cell construction, and duration of active cell operations, in exchange for a small increase in trucking costs for the short runs to the sanitary and TSCA facilities. This transportation cost could also be eliminated with the usage of a portable TSCA capable incinerator brought to the site.

If off-site disposal or recycling is deemed not achievable, organizing waste disposal into CERCLA and non-CERCLA (clean waste) cells could save engineering and construction costs by downgrading the labor, material, and quality control/quality assurance costs necessary for the construction of CERCLA level landfills.

Lastly, consider the use 4' x 8' x 20' intermodals for metal shipments. Due to the density of the metallic debris, allowable weight will be maximized before completely filling an 8' x 8' x 20' intermodal for shipping. Disposal fees for intermodals are based on the internal volume, regardless of how much quantity is inside.

C. Parametric Relationship Report

1.0 Executive Summary

In the writing of the estimate for the Portsmouth GDP demolition, there were several "what if" possibilities that the review team had to consider before completing the estimate's development. These options would, depending on the choice made, influence other elements further along in the estimate. The review team considered cost, time, and practicality in the parametric alternate option for the estimate input.
Parametric Choices

2.0 Delay Duration(s) of the Project or Project Segments

There are several delays that can affect the D&D project which are discussed below:

- Typical Project Delay – The project can expect to suffer some random delays within the life of the project and generally, the contractor will incur costs for delays within his control. The details of that delay would determine if the costs might be reimbursable. However, while most delays of this type cannot be estimated, some variable delays can be anticipated, if not exactly defined, such as in the Scenario VI estimate. A longer duration was given to the Plan & Prep phase of the D&D project to account for delays caused by the RCRA process.

- External Delay to the D&D Project – A delay could happen before the D&D project ever goes out for bidding for such reasons as funding constraints, scheduling conflicts, and regulatory conflicts. The D&D project would have to wait until a later date before a Request for Proposal could go out to contractors. An escalation factor to the estimate would bring costs into the appropriate time period. However, a decision would have to be made on the surveillance and maintenance of the facilities for the duration of the delay period. This delay parameter was not considered in Scenarios I-VI, but could be a decision factor in future scenarios.

- Scenario II Estimate Delay – The Scenario II estimate was based on an assumption that a 30 year delay would occur for a predetermined number of facilities in the D&D project while other facilities would undergo prompt D&D. This delay was not a parametric consideration as it was a fixed assumption in the creation of that scenario.

2.1. Segmenting Large Pipes and Converters

While Scenarios I, II, III, and VI in the estimate did not incorporate segmentation of the generated D&D waste as an assumption, Scenarios IV and V did. The non-segmentation scenarios used two criterion to support the assumption:

- None of the generated D&D waste would be segmented. It would be taken to and disposed of in the disposal-cell intact (as a whole); with no size reduction other than what was necessary to remove the equipment from the buildings or for transportation.

- The waste would be reasonably stacked in the disposal cell to minimize void space and maximize the cell volume. Excessive amounts of time would not be spent placing waste in the disposal cell.

However, within Scenarios IV and V, segmentation of the converters and pipes did not increase the duration of the project along the critical path. However, during the Field Work phase of the D&D project, segmentation did incur a significant increase in the manpower, capital equipment costs, and consumable materials. Decisions were required by the estimating team to determine the best setup and mode of operation for the segmentation process. This involved decision points for crushing pipes vs. total cutting of pipes, segmentation of pipes and converters in place vs. creation of segmentation shops in pre-existing buildings (Buildings 705 and 700 as segmentation facilities), and determining the minimal usage of cleared workers and security escorts. These involved weighing differing parameters such as creating segmentation shops would require certain building systems to be present, such as fire, ventilation, and radiation monitoring systems. However, this cost was counterbalanced by higher efficiency in segmentation, which contributes to lower LOE duration.

2.2. Varying both the Material and Waste Type(s) Shipped Off-site, and Varying the Off-Site Destination

The Scenario I estimate was constructed on the assumption that almost all of the generated D&D waste would be disposed in the onsite disposal cell with the exception of liquid wastes and select solid hazardous wastes. There are several advantages that can be taken from the use of an on-site disposal cell. On-site disposal eliminates cross-country transportation costs and disposal fees for taking waste to National Test Site (NTS) in Nevada and/or Envirocare in Utah. This would also apply to estimates for Scenarios II, IV, and VI.

At the same time, off-site disposal of wastes requires a significant increase to the manpower, capital equipment costs, and consumable material costs in the Off-Site Transportation & Disposal group during the Field Work phase of the D&D Project. This is where some adjustment to the shipping parameter can be made. Off-site shipping required the consideration of factors such as the use of trucking instead of rail transport, the selection and usability of various shipping containers, and the support services in terms of manpower, facilities, and load prepping procedures. The determination of the rate of delivery to the disposal sites, i.e. the rate of shipping, will be dictated by both the availability of transport, as well as the rate at which the off-site disposal can digest the waste being delivered to them. This last

factor could well become the driving consideration, as it determines the duration of the LOE staffing, equipment, and facilities.

2.3. Cutting or Conventional Demolition of GDP Building Floor Slabs

The estimate assumptions, while stating that the GDP buildings were to be demolished, did not specify the method by which to do it. The review team in developing the estimate had to consider whether to demolish the building slabs by conventional means, or to use alternative methods. The alternative method chosen uses a method in which the foundation slabs of the three gaseous diffusion process buildings will be cut into large blocks. While this method was judged impractical for all other buildings, which were estimated using a more traditional method, which calls for the foundation slabs to be broken in place with a pneumatic hammer and then removed.

The cutting method used for the process buildings offered advantages in terms of time savings, volume reduction, and the extent of the slab LOE. Demolishing the process buildings by means of traditional methods was less efficient due to the amount of manpower, equipment, and operating space required by the multiple crews that would be working in close proximity. By reducing the time required to demolish the slabs, the savings in LOE duration, as well as extent, made the use of the alternative method the more attractive choice.

2.4. Use of Owner's Representative Contractor

During the estimate creation, a decision had to be made concerning whether the D&D contractor should have responsibility for all management functions of the GDP D&D project, or whether the project oversight functions should be performed by an Owner's Representative contractor. The review team decided that past experience on large jobs indicates that the combined duties of contract management and project management tend to overwhelm even the largest contractors. Government agency oversight of large project management tasks also tends to be unsatisfactory due to competing projects, and lack of personnel, both in experience, as well as in staff quantity.

In the review team's experience, the extra LOE incurred by the Owner's Representative is compensated for by the enhanced quality of project management.

2.5. Creation of Simple or Complex Sorting and Packaging Crew for Off-site Transport of Waste

The review team for Scenario V had to consider what sort of waste packaging crew to create in the LOE to service the off-site segmented waste disposal requirement.

The issue was whether the savings in transport and disposal created by a larger more complex crew would exceed the larger crew. The larger crew gave the ability to have waste sorted and specifically packaged for disposal by truck or train, and to be directed to selected destinations, either Envirocare in Utah (general Low Level Waste disposal), NTS in Nevada (classified wastes), or possible local TSCA disposal sites in Ohio or Indiana. Without the more sophisticated approach, more waste would be commingled, leading to increased shipment to NTS by default. By cutting down the waste bound for NTS, it was agreed that the savings from reduced direct disposal costs to go to and at NTS, as well as the reduction in LOE duration, more than compensated for the increase in LOE extent from the larger waste handling crew.

2.6.Scheduling Decisions

During the building of the estimate schedule, a decision had to be made concerning the method of scheduling the demolition activities at the Portsmouth GDP. The choices presented were whether to schedule demolition activities in parallel, series, or in a mixed fashion. It was decided that mixed scheduling was the better choice. Completely parallel scheduling would save on project duration, however, the simultaneous activities would be prone to disruption from delays, and would dictate an increased scope of LOE required for duplicate personnel and equipment. Series scheduling, would streamline the amount of LOE required, but would drastically increase the duration of the demolition, increasing LOE, and creating a total duration that would probably be unacceptable. The mixed schedule had demolition with overlapping phases of activity, compressing the duration of demolition, but allowing a reduced quantity of equipment and manpower to be used.

2.7.Equipment Selection

Equipment was another decision point in the estimate process. The parameters of this decision were whether the estimate should consider the use of larger off road equipment to collect and haul demolition debris, or to make use of more standard over the road equipment. While the larger equipment would mean less cycles to haul the same volume of waste, it was decided that this approach would be decidedly inefficient due to waste supply. Upon calculation, it was realized that the demolition activities would be unable to supply the larger vehicles with a constant flow of waste for haulage to the waste disposal cells, or waste shipment point. In this case the demolition process inefficiencies dictated the equipment selection in the LOE.

2.8.Duration of Level of Effort Schedule Segments

The duration parameter was defined by three of the four schedule segments of the D&D project. While the demolition segment could be defined by selected

equipment capabilities and building square footages, the preparatory, transitional, and closure phases of the project could not be defined by calculation. These time periods had to be determined by appraisal of other projects, and the judgment of the review team, based upon their prior experiences. It is realized however, that this is a partly defined parameter, as those segments are dependent upon actions and decisions of others, and cannot be reliably predicted.

2.9.Other Considerations

There are many variables in the project that had cost and schedule implications. However, many of those variables were non-parameters for the purpose of the estimate process. Many variables were addressed in the assumptions list of the project. This left no decision to be made on how those variables should be acted upon. The possible cost and benefits of those assumptions have addressed in Deliverable #5, Risk Analysis section, and in Section A of this report, under Cost Savings.

3.0 Conclusion

Nine parametric variations have been illustrated. For the most part what they have in common is a comparison between increased LOE costs vs. reduced direct costs, for example the waste sorting/packaging LOE vs. increased shipping and disposal costs. Most decisions in the estimate were driven by the effect the decision would have on the Level of Effort. Due to the overwhelming majority of the estimate being composed of LOE, even small influences on duration or extent of the LOE could have large results.

D. Analysis of Converter Stabilization Methods

1.0 Introduction

Separate from the Project Time & Cost (PT&C) estimate for the Portsmouth Gaseous Diffusion Process plant decommissioning and demolition was the planning and estimating for the on-site CERCLA landfill, performed by a separate estimating team under a different contract. The landfill will be designed to store various low level radioactive wastes in addition to other hazardous and sanitary debris resulting from the demolition of the plant. It is assumed that the landfill will accommodate cover material subsidence related to the disintegration of buried debris such as empty converter shells and intact pipes, and that the landfill can permanently secure classified components.

However, PT&C has been asked to consider other alternatives to burying the pipes and converters intact. The need for filling the converters supposes that before the expected life of the landfill would be over, the steel hulls of converters would rust out and fail. One alternative, incorporated into several of the PT&C estimate scenarios is to cut converters into smaller pieces and crush pipes into denser forms. In this supplement to the estimate, PT&C considers the advantages and disadvantages of using various materials to fill the converters and pipes to reduce void space, and thus reduce cover subsidence in the landfill.

The PT&C team will compare the advantages and disadvantages of:

- Choosing to leave the vessels empty, and designing for cover subsidence
- Using grout as a medium to fill the converters and pipes
- Using sand as a medium to fill the converters and pipes
- Using expansive foam to fill the converters and pipes

2.0 Modes of Stabilization

2.1. Leave Vessels Empty (Nothing)

The first option considered (used in Scenarios I, II, IV, VI and VIII) was to do nothing to the pipes and converters. That is, debris would be disposed of intact in the landfill. The only size reduction that would take place would be what was necessary to enable loading into the haulage equipment to the landfill.

Advantages

The primary advantage to leaving the converter and piping debris empty and intact is one of cost. The Level of Effort costs for crews to either fill the empty large pipes and converters with foam, grout or sand could be substantial. This cost is avoided with the empty option, as well as enhancing worker safety because there are fewer labor hours involved and less exposure to safety risks. A small LOE

crew for workers with security with clearance is required to seal shut all openings on the converters. After that the converters and pipes can be hauled to the landfill or transport, and disposed.

Disadvantages
The primary disadvantage of leaving the pipes and converters "as-is" is that the efficiency of the landfill can be reduced due to the air space in the debris. Further, a greater magnitude of landfill cap cover subsidence can result from the deterioration and collapse of the converters and large pipes. However, filling the pipes and converters, while reducing the subsidence problem, does nothing to increase landfill efficiency. Additionally, the subcontractor designing the landfill has stated that it can be designed to withstand any anticipated cover subsidence due to debris void spaces, including items like large pipes and converters.

Doing nothing but sealing the penetrations on the converters also raises a security risk if someone were able to penetrate site security and excavate down to one of the disposed converters. The classified components would only be covered by the sealed openings.

2.2.Sand

The first recommended filler material for the converters and large pipes was regular dry fine grained sand.

Advantages
Sand is the most cost effective material of the alternatives considered. Fine dry sand does have good flow characteristics, and would flow into void spaces in the converters. Dry fine sand does not compress to any significant extent, and a converter or pipe completely filled with sand would not compact. Being dry sand, the lack of contributed moisture prevents any criticality concerns, and will contribute nothing towards corrosion of the converters.

Disadvantages
Sand is a bulky material. Mobile machinery would be required to pour sand into the converter spaces in the quantities needed. This would need to be accomplished at the burial site for the larger devices. The weight of a large converter filled with sand would be prohibitive. The weight may be in excess of the capacity of the overhead crane systems within the buildings, and regular trucking capability. Outdoor penetrations of the converters would complicate security measures, due to easier access by non-cleared individuals, as well as open sight lines to interested non-cleared parties.

Also, the need for filling the converters supposes that before the expected life of the landfill would be over, the steel hulls of converters would rust out and fail. This would lead to the collapse of the converters and cover subsidence in the landfill. However, if this proves true, loose sand filler should also fall out of the deteriorated

converters towards the bottom of the landfill, contributing less than anticipated support against cover subsidence.

Sand, while better at providing security for the classified components than sealing alone, has its flaws as well. Sand will not destroy, degrade or blind the components of the converters. Should someone manage to excavate the disposed converters and remove the sealed end caps, they would only need to scoop out the sand to the point of reaching the desired components.

2.3.Grout

The second converter and pipe filler material considered was cementacious grout.

Advantages
Grout, depending on the mix, can flow freely as a semi-liquid, providing nearly complete filling of the pipes and converters. The grout, once set, can provide structural support as the steel hull of the converters and pipes corrode away, inhibiting cover subsidence.

Additionally, grout would have the advantage of enhancing the security of the classified converter components. The cement like grout, would adhere to the components, and form a tough media to remove, should someone manage to excavate the disposed converters. Further, any removed items would have their pore spaces blinded by cement, and possibly undergo chemical modification from the alkali pH of the cement.

Disadvantages
The price of grout, compared to sand is substantially higher. Recent commodity markets for cement, the major component of grout, have seen record high prices in the last few years.

Mobile machinery would be required to pour grout into the converter spaces in the quantities needed. Additionally, this would need to be accomplished in the landfill itself at the burial site for the larger devices. The weight of a large converter filled with grout would prohibit movement. The weight may be in excess of the capacity of the overhead crane systems within the buildings, and regular trucking capability. Outdoor penetrations of the converters would complicate security measures, due to easier access by non-cleared individuals, as well as open sight lines to interested non-cleared parties.

Additionally, grout carries a large fraction of its bulk in water. While not likely, this water component can, under the right circumstances, promote criticality in pieces of equipment, even if those pieces had previously been considered sub-critical.

2.4.Foam

The third filler material for converters and large pipes was isocyanate foam.

Advantages

The primary advantage of foam is that it can expand upon injection to fill void spaces that might not be accessible using other void filling media. Additionally, some varieties of foam exhibit strong, long lasting rigidity. It is assumed that upon the failure of the walls of the converters and large diameter pipes, this foam will still support the weight of the overburden and debris above the pipes and converters, preventing significant cover subsidence. Finally, the application of foam, due to its relatively light weight, and relatively easy application methods, can be performed in or near the GDP buildings. This would simplify both the application process, as well as the security requirements necessary to inject the foam. Once treated in the GDP buildings, the foamed pipes and converters could be directly hauled to the landfill and placed therein.

Foam would also be useful for long term security concerns. While not as effective as grout, foam would provide a resistive media that would need to be removed before an individual could access components from an excavated converter. The foam would blind the pore spaces in those components, and would greatly raise the possibility of damaging the component in any attempt to remove the foam. Additionally, there is the possibility that long term contact of the foam with the barrier material in the converters could chemically alter the barrier material.

Disadvantages

The largest disadvantages to foaming are cost and time. The foaming media can be costly for the quantities involved. Some varieties of foam can be ordered in bulk quantities (i.e. tanker car), but the other filling media would still be less expensive on a cost per cubic foot filled basis. Additionally, the foam would need to be applied using customized machinery. The customized applicators would need to be purchased or leased. The foaming crews would either need to be leased from the vendors, or consist of site personnel trained for the job; either will need to be security cleared personnel. This would impose an additional LOE cost. Foams also have a flammability characteristic either from propellant or the media itself. This will introduce an additional concern for worker safety. Lastly, while testing has indicated that some varieties of foam could provide rigidity in lab conditions, there is the unknown as to whether those lab results will be duplicated in the field.

3.0 Comparison and Recommendation

Reviewing the considered stabilization options, the factors to be evaluated included: cost of material, cost of application (both time to apply as well as requirement for specialized equipment or handling), simplicity of application, effectiveness at providing long term security to classified components and prevention of cover subsidence. Table 3.0-1 below compares the stabilization options against these factors:

Stabilization Option	Cost of Media	Cost of Application	Long-Term Security	Prevention of Cover Subsidence	Overall Usability
Sealing Only	Best	Best	Poor	Poor	Best
Sand	Moderate	Moderate	Poor	Poor	Poor
Grout	Poor	Poor	Best	Best	Best
Foam	Poor	Poor	Best	Best	Best

Table 3.0-1 Comparison of Converter and Pipe Filler Materials

Comparing these options, it would seem that grout fill is as feasible as burying the converters with welded or other permanent exterior seals only. While sealing only would be less costly in terms of both material and accumulated LOE costs, grout would enhance the long term security of the converters and prevent cover subsidence should the converter and pipe walls fail with time. However, the contractor designing the landfill has stated that the landfill can be designed to compensate for any cover subsidence that takes place. The contractor has also stated that the extra cost of this would be negligible, if incorporated early in the design stage. That being the case, the need to reduce cover subsidence from failed converters and pipes becomes a non-factor. If this is true the comparisons between media would look like these presented in Table 3.0-2:

Stabilization Option	Cost of Media	Cost of Application	Long-Term Security	Overall Usability
Sealing Only	Best	Best	Poor	Best
Sand	Moderate	Moderate	Poor	Poor
Grout	Poor	Poor	Best	Moderate
Foam	Poor	Poor	Best	Moderate

Table 3.0-2 Comparison of Converter and Pipe Filler Materials,
Cover Subsidence a Non-Issue

Lastly, it is assumed that the landfill at Portsmouth will have a permanent security presence, given the material that would be buried in it, as well as the continuing activity at the Portsmouth site adjacent to it. If this is the case, the criteria for long term security while still important, becomes less critical.

Given the need to reduce costs as much as possible, the probable long term security arrangements at the Portsmouth site, and the non-issue of landfill cover subsidence, PT&C recommends sealing the large pipes and converters, and burying those empty items into the on-site landfill.